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ASSESSMENT INVESTIGATION:
ABITIBI CONSOLIDATED
FORT FRANCIS

MAY 1998



**Ministry
of the
Environment**

ISBN 0-7778-7443-1

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PIBS 3637E

Phytotoxicology 1996 Assessment Investigation: Abitibi Consolidated - Fort Frances.

SDB-013-3511-97

Introduction

The ThunderBay District office of the Ministry of Environment and Energy (MOEE) office requested the Phytotoxicology Section, Standards Development Branch, MOEE conduct a terrestrial effects vegetation investigation in the vicinity of the Abitibi Consolidated, formerly Stone Consolidated and Boise Cascade, bleached kraft pulp mill in Fort Frances during the 1996 growing season.

During the first years of operations, emissions from the mill resulted in particulate fallout and odour problems in a nearby residential area. In the late 1970s, some emission reductions were achieved. In 1980, a Control Order was issued for further pollution controls. The mill also created a "buffer zone" through purchase of adjacent residential land.

Since 1972, terrestrial effects vegetation studies have been conducted regularly as part of air quality studies conducted in Fort Frances. Periodically since 1974 these studies have included a similar plant on the US side of the border (1,2,3).

Investigation

On August 13 and 14, 1996, Randall Jones and William McIlveen of the Phytotoxicology Section, and Don Racette of the Northern Region conducted a vegetation investigation in the vicinity of Abitibi Consolidated, Fort Frances. Duplicate Manitoba maple foliage samples were collected at 19 stations, 17 in Fort Frances, Ontario and two in International Falls, Minnesota (see Figure 1). Standard Phytotoxicology Section sampling procedures (4) were used during the investigation. As the foliage was being analysed for sodium and chloride, the investigators wore plastic protective coverings on their hands to avoid possible sample contamination from sweat.

The samples were transported to the Phytotoxicology Sample Process Laboratory where they were dried and ground. The processed samples were submitted to the Laboratory Services Branch for analysis of sodium, chlorine, and sulphur.

In addition to the samples collected for chemical analysis, visual observations were recorded of the conditions of the trees sampled and any injury observed on the tree leaves.

Results

The results of the chemical analysis of the Manitoba maple foliage for sodium and chlorine are given in Tables 1 and 2 respectively. The 1996 results for each station are the mean of the duplicate samples and are expressed in either $\mu\text{g/g}$ dry weight, or percentage dry weight. Stations 26, and 27 are considered control locations. For comparison purposes, the results from the 1980, 1992, 1993, 1994, and 1995 investigations are given in each table. The average sodium concentrations for stations 1 to 6, and 9 to 28, excluding the controls and sites in International Falls, from the six investigations are graphed in Figure 2. Similarly, the average chlorine concentrations for stations 1 to 6, and 9 to 28, excluding the controls and sites in International Falls, from the six investigations are graphed in Figure 3.

The visual observations of tree condition, and leaf injury are given in Table 3. Due to the severe hail storm on the morning of August 13, all of the trees suffered from hail damage to the leaves, with up to 50% of the leaves knocked off at some locations. This complicated, but did not invalidate, the visual assessment.

Discussion

There was a pattern of marginally elevated concentrations of sodium in Manitoba maple foliage in the buffer zone immediately north and east of the Abitibi Consolidated kraft pulp mill. The six stations, 1 to 6, in this zone ranged from 35 to 150 $\mu\text{g/gm}$ dry weight, with an average value of 85 $\mu\text{g/gm}$. The rest of the sampling stations in Fort Frances averaged 28 $\mu\text{g/gm}$, which was approximately twice the concentration of the two controls, Stations 26 and 27. All results were well below the Urban Upper Limits of Normal for sodium in vegetation (see Appendix). The sodium concentrations in 1996 are similar to what has been reported in the four previous investigations, 1992 to 1995, and are significantly below the concentrations found in 1980, see figure 2. Phytotoxicology ULN guidelines for sodium in vegetation have not been exceeded at the same sites in the last five investigations.

There was no pattern of decreasing chlorine concentration in Manitoba maple foliage with increasing distance from the pulp mill. While there were some elevated levels near the plant, specifically Stations 2 and 5, other nearby stations, for example 1 and 6, were comparable to the control stations. There was no correlation between the concentrations of sodium and chlorine. The chlorine concentrations in 1996 are similar to what has been reported in the four previous investigations, 1992 to 1995, and are significantly below the concentrations found in 1980 (see Figure 3).

All of the visible injury observed on the Manitoba maple trees sampled for this investigation could be attributed to insects, physiological stress, and maturity of the trees. There was no evidence of injury related to air pollution.

Conclusions

The Abitibi Consolidated bleached kraft pulp mill in Fort Frances continues to be a minor source of sodium emissions resulting in marginally elevated concentrations in Manitoba maple foliage in the buffer zone to the immediate north and east of the mill. No evidence of elevated chlorine concentrations were found in Manitoba maple foliage. Naturally higher and more variable concentrations of chlorine found in vegetation may mask out any marginal increase in levels that may result from emissions from the company, making data interpretation more difficult for this element. On average, the concentrations of both chlorine and sodium in Manitoba maple foliage were the lowest of the last five surveys conducted around the mill and are well below the values found in the 1970s and early 1980s.

References

1. Griffin, D. and D. Racette, Air Quality Northwestern Ontario Annual Report 1991, Ontario Ministry of Environment, Northwest Region, PIBS 2108, 1992.
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4. McIlveen, W.D. and D.L. McLaughlin, Field Investigation Manual Part 1 - General Methodology, Ontario Ministry of Environment and Energy, Phytotoxicology Section, Report No. 014-3511-93, 1993.

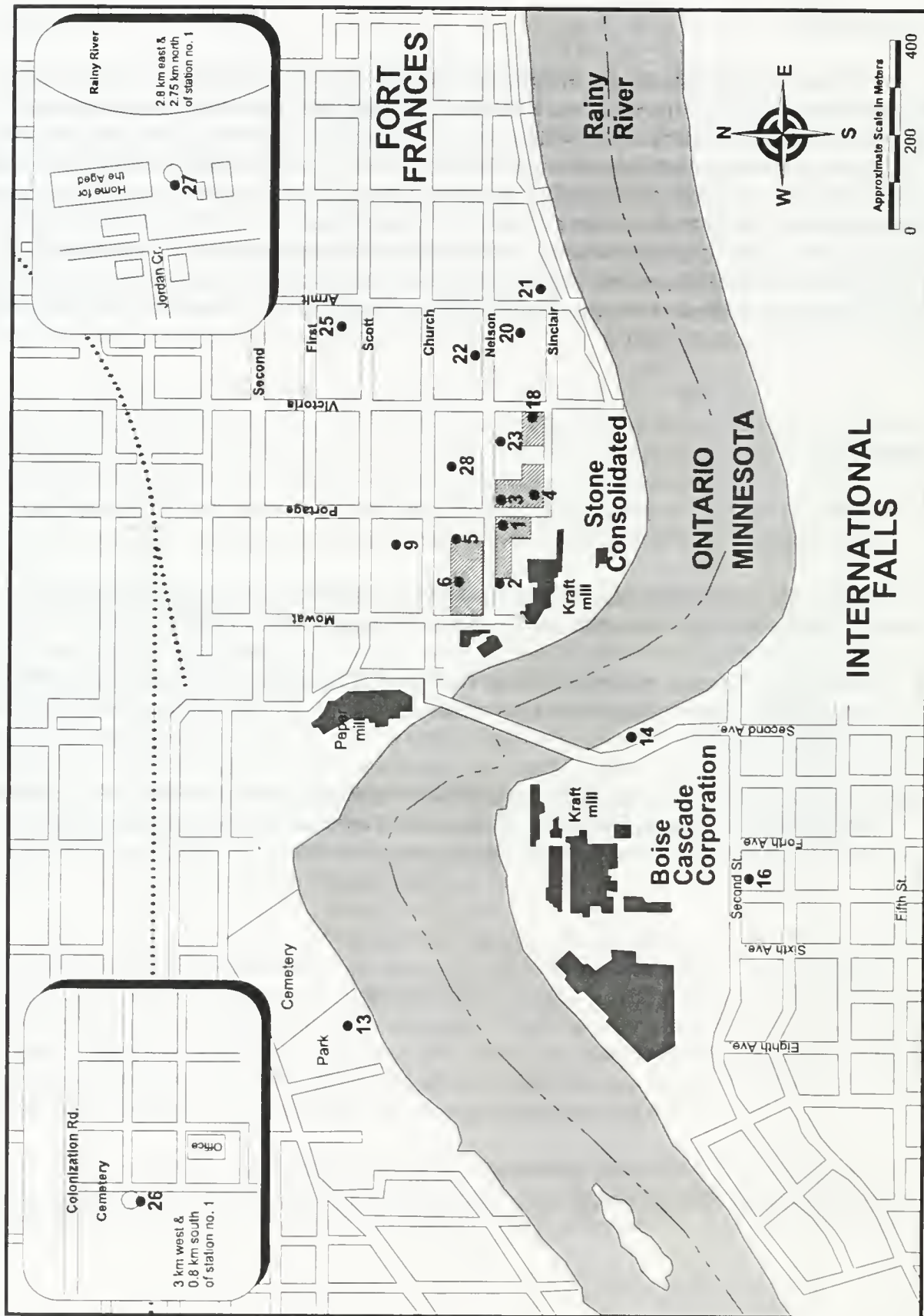


Figure 1. Manitoba maple sampling sites, Fort Frances, August 13-14, 1996.  Buffer zone

Figure 2: Mean Sodium Concentration in Manitoba Maple Foliage - Abitibi Consolidated Fort Frances

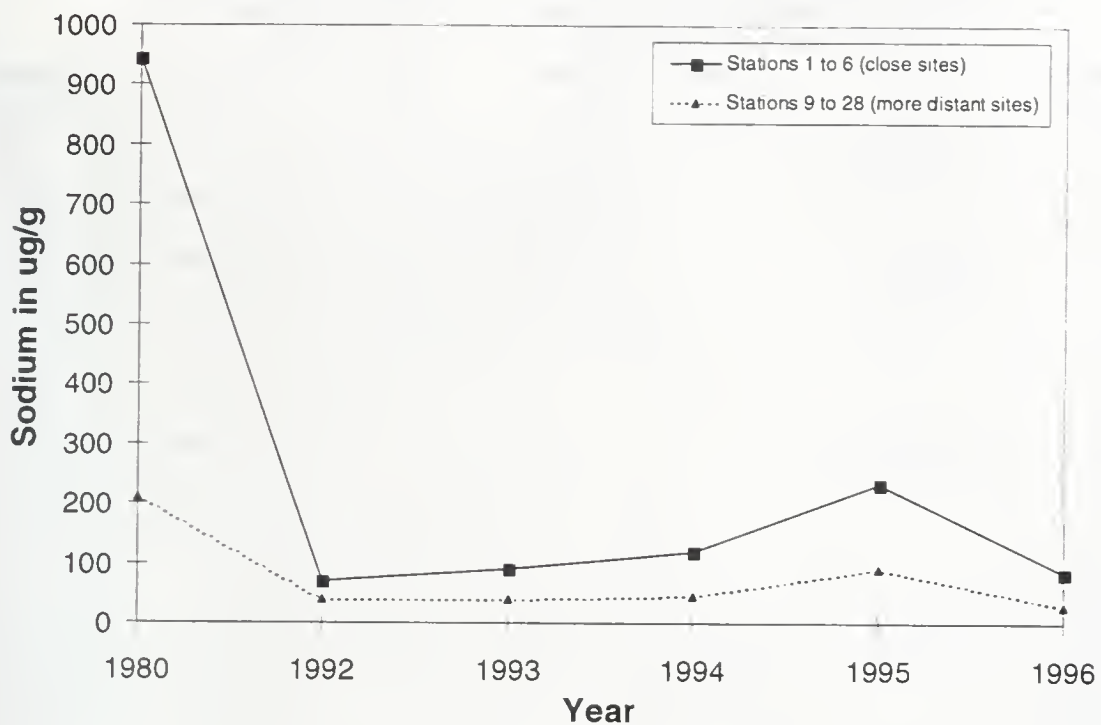


Figure 3: Mean Chlorine Concentration in Manitoba Maple Foliage

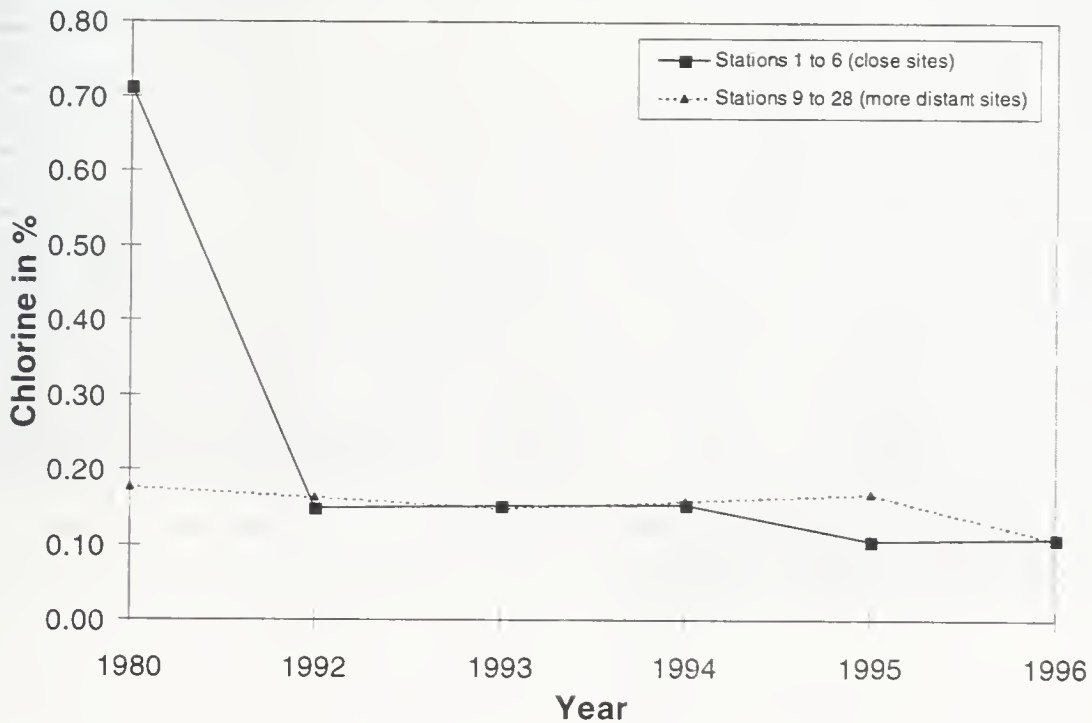


Table 1: Mean sodium concentrations in µg/gm dry weight in Manitoba maple foliage collected at 19 sites in the vicinity of Abitibi Consolidated, Fort Frances, 1980, 1992, 1993, 1994, 1995, and August 13-14, 1996

Station	1980	1992	1993	1994	1995	1996
1	<u>1800</u>	100	95	190	280	150
2	<u>1400</u>	60	100	90	330	81
3	<u>1200</u>	82	85	110	200	109
4	<u>620</u>	92	100	170	270	71
5	260	37	60	95	170	35
6	<u>390</u>	47	100	60	150	61
9	150	49	75	65	170	36
13	83	19	30	30	40	15
14	53	47	55	50	60	46
16	73	42	40	50	50	30
18	120	59	40	65	130	32
20	250	31	45	30	80	22
21	250	27	30	36	60	20
22	140	40	50	35	80	41
23	280	39	35	40	80	35
25	<u>410</u>	45	35	45	80	27
28	ND	37	30	55	90	26
26 ^c	100	24	20	25	30	17
27 ^c	100	26	ND	ND	40	15
ULN	<u>350</u>	350	350	350	350	350

^c - control stations, ND - no data

ULN - Phytotoxicology Upper Limit of Normal guideline for sodium in vegetation, see Appendix.

- shaded data exceed ULN guideline.

Table 2: Concentration of Chlorine as % dry weight in Manitoba Maple Foliage Collected at 19 Sites in the Vicinity of Abitibi Consolidated, Fort Frances, 1980, 1992, 1993, 1994, and August 13-14, 1996

Station	1980	1992	1993	1994	1995	1996
1	1.17	0.10	0.07	0.10	0.05	0.05
2	0.81	0.19	0.20	0.23	0.18	0.15
3	0.87	0.19	0.15	0.15	0.12	0.18
4	0.71	0.12	0.27	0.15	0.11	0.12
5	0.35	0.15	0.11	0.17	0.12	0.11
6	0.36	0.14	0.11	0.12	0.05	0.04
9	0.22	0.20	0.32	0.16	0.32	0.13
13	ND	0.03	0.02	0.02	0.03	0.01
14	0.08	0.06	0.04	0.08	0.05	0.09
16	0.53	0.16	0.15	0.39	0.42	0.40
18	0.21	0.31	0.10	0.24	0.22	0.11
20	0.10	0.16	0.11	0.14	0.16	0.09
21	0.15	0.09	0.13	0.18	0.08	0.07
22	0.13	0.20	0.16	0.12	0.12	0.06
23	0.26	0.22	0.19	0.25	0.15	0.16
25	0.17	0.11	0.14	0.15	0.30	0.14
28	ND	0.15	0.17	0.17	0.13	0.19
26 ^c	0.07	0.12	0.04	0.09	0.27	0.07
27 ^c	0.12	0.08	0.07	0.11	0.05	0.04

^c - control stations, ND - no data
ULN guideline for chloride in vegetation is not available.

Table 3: Visual Observations of Tree Condition and Foliar Injury to Manitoba Maple at 19 Sites in the Vicinity of Abitibi Consolidated, Fort Frances on August 13-14, 1996

Station	Foliar Injury and Tree Condition
1	Trace marginal necrosis on foliage. Mature tree in moderate to poor condition.
2	Foliage had trace to light marginal necrosis, was mildly chlorotic, and had a red undersurface. Mature tree in poor condition.
3	Foliage suffering from typical insect damage. Small leaves. Mature tree in poor shape.
4	Foliage suffering from typical insect damage, and trace tip necrosis. Mature tree in poor shape.
5	Foliage had trace insect injury and galls. Young approximately 6 m high tree in moderate condition.
6	Foliage had trace marginal injury on older leaves, and moderate insect damage. Original tree gone, replace with young approximately 6 m high tree in good condition.
9	Foliage small, suffering from insect damage and likely a viral infection. Mature tree cut down to approximately 4 m high with new suckers at top.
13	Foliage small and chlorotic, with typical insect damage. Tree in poor condition.
14	Foliage had trace terminal necrosis, and typical insect damage. Mature tree in moderate condition.
16	Foliage had typical insect damage. Small sparse tree.
18	Foliage small and chlorotic, with typical insect damage. Mature tree in poor condition with approximately 70% of crown dead.
20	Foliage had trace chlorosis, with typical insect damage. Original tree gone, replace with young approximately 6 m high tree 20 m east of original tree.
21	Foliage had trace chlorosis, with typical insect damage. Mature tree in moderate condition.
22	Foliage had typical insect damage. Mature tree in good condition.
23	Foliage had typical insect damage. Mature tree in good condition.
25	Foliage had typical insect damage. Mature tree in good condition.
28	Foliage had typical insect damage. Mature tree in good condition.
26	Foliage had typical insect injury. Mature tree in good condition.
27	Foliage had trace terminal necrosis and trace insect damage. Mature tree in good condition.

Appendix

Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: *Ontario Ministry of the Environment. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section, Air Resources Branch: Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto. ISBN: 0-7729-5143-8.*). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.

